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1. Your reference

Water mist patent 1

2. Patent application number
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2 6 FEB 2004 **0404230.5**

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

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Patents ADP number *(if you know it)* 8333072002

If the applicant is a corporate body, give the country/state of its incorporation

4. Title of the invention

Water Mist Generator

5. Name of your agent *(if you have one)* (51/77 - 7.4.05)

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Signature(s) Date 25/2/04

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Water Mist Generator

This invention relates to a mist generator

The present invention has reference to an apparatus and method for the generation of a liquid droplet mist with application to, but not restricted to, water mist generation for fire extinguishing, suppression and control. Hereinafter the present invention will be described with reference to the use of water but any other liquid can be used specific to the application. For example, for fire suppression any non-flammable liquid which absorbs heat when it vaporises may be used.

It is well known in the art that there are three major contributing factors required to maintain combustion. These are known as the fire triangle, i.e. fuel, heat and oxygen. Conventional fire extinguishing and suppression systems aim to remove or at least minimise at least one of these major factors. Typically fire suppression systems use inter alia water, CO2, Halon, dry powder or foam. Water systems act by removing the heat from the fire, whilst CO2 works by displacing the oxygen.

Another aspect of combustion is known as the flame chain reaction. The reaction relies on free radicals that are created in the combustion process and are essential for its continuation. Halon operates by attaching itself to the free radicals and thus preventing further combustion by interrupting the flame chain reaction.

The major disadvantage of water systems is that a large amount of water is usually required to extinguish the fire. This presents a first problem of being able to store a sufficient volume of water or quickly gain access to an adequate supply. In addition, such systems can also lead to damage by the water itself, either in the immediate region of the fire, or even from water seepage to adjoining rooms. CO2 and Halon systems have the disadvantage that they cannot be used in environments where people are present as it creates an atmosphere that becomes difficult or even impossible for people to breathe in. Halon has the further disadvantage of being toxic and damaging

to the environment. For these reasons the manufacture of Halon fire suppression systems is being banned in most countries.

To overcome the above disadvantages a number of alternative systems utilising liquid mist have emerged. The majority of these utilise water as the suppression media, but present it to the fire in the form of a water mist. A water mist system overcomes the above disadvantages of conventional systems by using the water mist to reduce the heat of the vapour around the fire, displace the oxygen and also disrupt the flame chain reaction. Such systems use a relatively small amount of water and are generally intended for class A and B fires, and even electrical fires.

Current water mist systems utilise a variety of methods for generating the water droplets, using a range of pressures. A major disadvantage of many of these systems is that they require a relatively high pressure to force the water through injection nozzles and/or use relatively small nozzle orifices to form the water mist. Typically these pressures are 20bar or greater. As such, many systems utilise a gas-pressurised tank to provide the pressurised water, thus limiting the run time of the system. Such systems are usually employed in closed areas of known volume such as engine rooms, pump rooms, and computer rooms. However, due to their finite storage capacity, such systems have the limitation of a short run time. Under some circumstances, such as a particularly fierce fire, or if the room is no longer sealed, the system may empty before the fire is extinguished. Another major disadvantage of these systems is that the water mist from these nozzles does not have a particularly long reach, and as such the nozzles are usually fixed in place around the room to ensure adequate coverage.

Conventional water mist systems use a high pressure nozzle to create the water droplet mist. Due to the droplet formation mechanism of such a system, and the high tendency for droplet coalescence, an additional limitation of this form of mist generation is that it creates a mist with a range of water droplet sizes. It is known that water droplets of approximately 40-50μm in size provide the optimum compromise for fire suppression for a number of fire scenarios. For example, a study by the US Naval Research

Laboratories found that a water mist with droplets less than 42μm in size was more effective at extinguishing a test fire than Halon 1301. A water mist comprised of droplets in the approximate size range of 40-50μm provides the greatest surface area for a given volume, whilst also providing sufficient mass to project a sufficient distance and to also penetrate into the heat of the fire. The majority of conventional water mist systems only manage to achieve a low percentage of the water droplets in this key size range.

An additional disadvantage of the conventional water mist systems, generating a water mist with such a wide range of droplet sizes, is that the majority of fire suppression requires line-of-sight operation. Although the smaller droplets will tend to behave as a gas the larger droplets in the flow will themselves impact with these smaller droplets so reducing their effectiveness. A mist which behaves more akin to a gas cloud has the advantages of reaching non line-of-sight areas, so eliminating all hot spots and possible re-ignition zones. A further advantage of such a gas cloud behaviour is that the water droplets have more of a tendency to remain airborne, thereby cooling the gases and combustion products of the fire, rather than impacting the surfaces of the room. This improves the rate of cooling of the fire and also reduces damage to items in the vicinity of the fire.

An object of the present invention is to provide a water mist generator having an improved performance than water mist systems currently available.

According to a first aspect of the present invention a mist generator includes a hollow body provided with a straight-through passage with an inlet at one end of the passage and an outlet at the other end of the passage for the entry of a first fluid, and discharge respectively of a dispersed droplet flow mixture, a nozzle substantially circumscribing and opening into said passage intermediate the inlet and outlet ends thereof, an inlet communicating with the nozzle for the introduction of a transport fluid, a mixing chamber being formed within the passage downstream of the nozzle, the nozzle being

so disposed and configured that in use a dispersed droplet flow regime is created within the mixing chamber by the introduction of the transport fluid.

The transport fluid is preferably a compressible fluid and may be a gas or vapor, for example steam, which may be introduced in either a continuous or discontinuous manner.

According to a second aspect of the present invention a mist generator includes a hollow body provided with a straight-through passage with an inlet at one end of the passage and an outlet at the other end of the passage for the entry of a first fluid and discharge respectively of a dispersed droplet flow mixture, a nozzle substantially circumscribing and opening into said passage intermediate the inlet and outlet ends thereof, an inlet communicating with the nozzle for the introduction of steam, a mixing chamber being formed within the passage downstream of the nozzle, the nozzle being so disposed and configured that in use a dispersed droplet flow regime is created within the mixing chamber by the introduction of steam.

The mist generator may be provided with one or more fluid inlets, for example for the introduction of a liquid or liquids, and/or a gas or gasses, and/or a powder or powders, provided in the passage intermediate the inlet and the outlet. The fluid inlet or inlets may circumscribe the passage and may therefore be of annular form and may be located upstream and/or downstream of and/or coincident with the nozzle for the transport fluid or steam.

The first fluid may be a gas, for example air, a liquid, for example water, a mixture of a gas and a liquid, or may be a powder or mixture of powder and liquid and/or gas. In some applications this first fluid may be an inert gas.

Hereinafter the liquid, or liquids, or mixture of liquids and gases, or mixture of powder and liquid and/or gas, introduced into the unit to be mixed and dispersed into a droplet form will be referred to as the 'working fluid'.

The mechanism of the present invention primarily relies on the momentum transfer between the transport fluid and the working fluid, which provides for shearing of the working fluid on a continuous basis by shear dispersion and/or dissociation, plus provides the driving force to propel the generated mist out of the outlet. However, when the transport fluid is a hot compressible gas, for example steam, i.e. the transport fluid is of a higher temperature than the working fluid, it is thought that this mechanism is further enhanced with a degree of mass transfer between the transport fluid and the working fluid as well. Again, when the transport fluid is hotter than the working fluid the heat transfer between the fluids and the resulting increase in temperature of the working fluid further aids the dissociation of the liquid into smaller droplets by reducing the surface tension of the liquid.

The intensity of the shearing mechanism, and therefore the size of the droplets created, and the propelling force of the mist is controllable by manipulating the various parameters prevailing within the system when operational. Accordingly the flow rate, pressure and quality, e.g. in the case of steam the dryness, of the transport fluid may be regulated to give the required intensity of shearing and droplet formation. Similarly, the flow rates, velocities and temperatures of the fluids which make up the working fluid, which are either entrained or pumped into the mist generator, may be regulated to give the required intensity of shearing and droplet formation.

The passage may be of any convenient cross-sectional shape suitable for the particular application of the mist generator. The passage shape may be circular, rectilinear or any intermediate shape, for example curvilinear.

The nozzle may be located as close as possible to the projected surface of the working fluid, in practice and in this respect a knife edge separation between the transport fluid or steam and the working fluid stream or streams may be of advantage in order to achieve the requisite degree of interaction. The angular orientation of the nozzle with

respect to the flow of the working fluid stream or streams is of importance and may be shallow.

In some embodiments of the present invention a series of nozzles is provided lengthwise of the passage and the geometry of the nozzles may vary from one to the other dependent upon the effect desired. For example, the angular orientation may vary one to the other. The nozzles may have differing geometries in order to afford different effects, i.e. different performance characteristics, with possibly differing parametric steam conditions. For example some nozzles may be operated for the purpose of initial mixing of different liquids and gases whereas others are used simultaneously for additional droplet breakup or flow directionalisation. Each nozzle will have a mixing chamber section downstream thereof. In the case where a series of nozzles is provided the number of operational nozzles is variable.

The nozzle may be of a form to correspond with the shape of the passage and thus for example a circular passage would advantageously be provided with an annular nozzle circumscribing it. The term 'annular' as used herein is deemed to embrace any configuration of nozzle or nozzles that circumscribes the passage of the mist generator.

In the case of a rectilinear passage, which may have a large width to height ratio, nozzles would be provided at least on each transverse wall, but not necessarily on the sidewalls, although the invention optionally contemplates a full circumscription of the passage by the nozzle irrespective of shape.

The or each nozzle may be continuous or may be discontinuous in the form of a plurality of apertures, e.g. segmental, arranged in a circumscribing pattern that may be circular. In either case each aperture may be provided with helical vanes formed in order to give in practice a swirl to the flow of the transport fluid. As a further alternative the nozzle may circumscribe the passage in the form of a continuous helical scroll over a length of the passage, the nozzle aperture being formed in the wall of the passage.

The or each nozzle may be of a convergent-divergent geometry internally thereof, and in practice the nozzle is configured to give the supersonic flow of transport fluid within the passage. For a given steam condition, i.e. dryness, pressure and temperature, the nozzle is preferably configured to provide the highest velocity steam jet, the lowest pressure drop and the highest enthalpy.

For example only, and not by way of limitation, an optimum area ratio for the nozzle, namely exit area: throat area, lies in the range 1.75 and 7.5, with an included angle of less than 9°.

The or each nozzle is conveniently angled towards the flow since this occasions penetration of the working fluid and advantageously prevents both kinetic energy dissipation on the wall of the passage and, for hot transport fluids such as steam, premature condensation of the transport fluid at the wall of the passage, where an adverse temperature differential prevails. The angular orientation of the nozzles is selected for optimum performance which is dependent inter alia on the nozzle orientation and the internal geometry of the mixing chamber. Moreover, the creation of turbulence, governed inter alia by the angular orientation of the nozzle, is important to achieve optimum performance by dispersal of the working fluid in order to increase acceleration by momentum transfer and mass transfer. For example, and not by way of limitation, in the present invention it has been found that an angular orientation for the or each nozzle may lie in the range 0 to 30° to the local mean flow of working fluid.

The mixing chamber geometry is determined by the desired and projected output performance and to match the designed steam conditions and nozzle geometry. In this respect it will be appreciated that there is a combinatory effect as between the various geometric features and their effect on performance, namely droplet size, droplet density, mist spray cone angle and projected distance.

The cross-sectional area of the mixing chamber may vary with length and may have differing degrees of reduction or expansion along its length, i.e. the mixing chamber may taper at different angles at different points along its length. The mixing chamber tapers from the location of the or each nozzle and the taper ratio is selected such that the multi-phase flow velocity and trajectory is maintained at its optimum or desired position.

The mixing chamber of the present invention may be of variable length in order to provide a control on the droplet formation parameters i.e. droplet size, velocity and spray cone angle. The length of the mixing chamber is thus chosen to provide the optimum performance regarding momentum transfer. In some expressions of the invention the length may be adjustable in situ rather than pre-designed in order to provide a measure of versatility.

A cowl may be provided downstream of the outlet from the passage in order to further control the mist spray cone angle and projected distance. The cowl may comprise of a number of separate sections arranged in the radial direction, each section controlling and re-directing a portion of the mist spray emerging from the outlet of the mist generator.

The mist generator may be positioned within a further cowl which envelopes the mist generator in order to allow more of the first fluid to be entrained through the gap between the external wall of the mist generator and the internal wall of the cowl.

The fluid inlet or other inlets which may be provided in the passage may be used for the introduction of gases or liquids or of other additives that may for example be treatment substances for the working fluid or may be particulates in powder or pulverulent form to be mixed with the working fluid. For example, the or additional water may be introduced via a fluid inlet or inlets for water mist applications. The fluids or other additives are entrained into the mist generator by the low pressure

created within the unit. The fluids or additives can also be pressurised by an external means and pumped into the mist generator, if so required.

The fluid inlet or inlets may be of a form to correspond with the shape of the passage and/or the transport fluid nozzle and thus for example a circular passage would advantageously be provided with an annular fluid inlet or inlets circumscribing it.

In the case of a rectilinear passage, which may have a large width to height ratio, a fluid inlet or inlets would be provided at least on each transverse wall, but not necessarily on the sidewalls, although the invention optionally contemplates a full circumscription of the passage by the fluid inlet irrespective of shape.

The or each fluid inlet may be continuous or may be discontinuous in the form of a plurality of apertures, e.g. segmental, or a series of holes, arranged in a circumscribing pattern that may be circular. Each aperture may be provided with helical vanes formed in order to give in practice a swirl to the flow of the working fluid. As a further alternative the fluid inlet or inlets may circumscribe the passage in the form of a continuous helical scroll over a length of the passage, the fluid inlet aperture being formed in the wall of the passage.

According to a further aspect of the present invention a method of creating and moving a mist includes presenting a working fluid, possibly formed from a mixture of one or more different liquids and gasses and/or powders, to a mist generator, the generator having a straight-through passage, applying a substantially circumscribing stream of transport fluid to the passage through an annular nozzle, inducing flow of the working fluid through the passage from an inlet and/or fluid inlets to an outlet thereof, and modulating the shearing mechanism to vary the working fluid mist discharge from the outlet.

The transport fluid is preferably a compressible fluid and may be a hot gas or vapour, for example steam.

According to a further aspect of the present invention a method of creating and moving a mist includes presenting a working fluid possibly formed from a mixture of one or more different liquids and/or gasses and/or powders, to a mist generator, the generator having a straight-through passage, applying a substantially circumscribing stream of steam to the passage through an annular nozzle, inducing flow of the working fluid through the passage from an inlet and/or fluid inlets to an outlet thereof, and modulating the shearing mechanism to vary the working fluid mist discharge from the outlet.

The method of the present invention involves the transfer of energy to the working fluid by momentum transfer (plus mass transfer for hot transport fluids such as steam) as the transport fluid is accelerated to supersonic speeds and directed by the nozzle into the working fluid. The resulting high velocity mixture of the transport and working fluid exits via the outlet.

In carrying out the method of the present invention the creation and intensity of the dispersed droplet flow is occasioned by the design of the nozzle interacting with the setting of the desired parametric conditions, for example in the case of steam as the transport fluid the pressure, the dryness or steam quality, the temperature and the flow rate to achieve the required performance of the steam nozzle.

The treatment of the working fluid, for example mixing, dispersing and projecting etc may occur in a single unit using one or more nozzles or by way of an in-line configuration using one or more mist generators as required.

The water mist generator of the present invention may be employed in a variety of applications ranging from fire extinguishing, suppression and control to smoke or particle wetting. In its application to fire extinguishing, suppression and control, a variety of working fluids may be moved and may include liquids, liquids with particles in suspension, and the like. It is an advantage of the straight-through passage of the

generator, and the relatively large inlet nozzle geometries, that it can accommodate material that might find its way into the passage. It is a feature of the present invention that it is far more tolerant of the water quality used than conventional water mist systems which depend on small orifices and close tolerance nozzles.

The invention may also be used for mixing, dispersion or hydration and again the shearing mechanism provides the mechanism for achieving the desired result. In this connection the mist generator may be used for mixing one or more fluids, one or more fluids and solids in particulate form, for example powders. The fluids may be in liquid or gaseous form. This mechanism could be used for example in the fighting of forest fires, where powders and other additives, such as fire suppressants, can be entrained, mixed and dispersed with the mist spray.

In this area of usage also lies another potential application in terms of foam generation for fire fighting purposes. The separate fluids, for example water, a foaming agent, and possibly air, are mixed within the mist generator using the transport fluid, e.g. steam, by virtue of the shearing effect.

The finely dispersed spray produced by the mist generator might be advantageously employed where there has been a leakage or escape of chemical or biological materials in liquid or gaseous form. The atomised spray provides a mist which effectively creates a blanket saturation of the prevailing atmosphere giving a thorough wetting result. In the case where chemical or biological materials are involved, the mist wets the materials and occasions their precipitation or neutralization. Additional treatment could be provided by the introduction or entrainment of chemical or biological additives into the working fluid. For example disinfectants may be entrained or introduced into the mist generator, and introduced into a room to be disinfected in a mist form. For decontamination applications no pre-mix of the chemicals is required as the chemicals can be entrained directly into the unit and mixed simultaneously. This greatly reduces the time required to start decontamination and also eliminates the requirement for a separate mixer and holding tank.

The mist generator may be deployed as an extractor whereby the injection of the transport fluid, for example steam, effects induction of a gas for movement from one zone to another. One example of use in this way is to be found in fire fighting when smoke extraction at the scene of a fire is required. The present invention has the additional benefit of wetting or quenching of explosive or toxic atmospheres utilising either just the steam, or with additional entrained water and/or chemical additives. The latter configuration could be used for placing the explosive or toxic substances into solution for safe disposal.

Further the mist generator may be employed for scrubbing particulate materials from a gas stream, to effect separation of the wanted from the waste elements. Additional chemical additives in fluid and/or powder form may be entrained and mixed with the flow for treatment of the gas and/or particulates. This usage has particular, but not exclusive, application to industrial exhaust scrubbers and dust extraction systems.

The performance of the present invention can be complimented with the choice of materials from which it is constructed. Although the chosen materials have to be suitable for the temperature, steam pressure and working fluid, there are no other restrictions on choice.

By way of example, five embodiments of a mist generator in accordance with the present invention are described below with reference to the accompanying drawings in which:

Figure 1 is a cross sectional elevation of a first embodiment;
Figure 2 is a cross sectional elevation of a second embodiment with respective end views shown;
Figure 3 is a cross sectional elevation of a third embodiment;
Figure 4 is a cross sectional elevation of a fourth embodiment; and

Figure 5 is a cross sectional elevation of a fifth embodiment with respective end views shown.

Like numerals of reference have been used for like parts throughout the specification. In these examples steam is used as the transport fluid, water the liquid to be dispersed, and air the first fluid.

Referring to Figure 1 there is shown a mist generator 1 comprising a housing 2 defining a passage 3 providing an inlet 4 and an outlet 5, the passage 3 being of substantially constant circular cross section.

The inlet 4 is formed at the front end of a protrusion 6 extending into the housing 2 and defining exteriorly thereof a plenum 8 for the introduction of a transport fluid, the plenum 8 being provided with a feed port 10. The protrusion 6 defines internally thereof part of the passage 3. The distal end 12 of the protrusion 6 remote from the inlet 4 is tapered on its relatively outer surface at 14 and defines an annular nozzle 16 between it and a correspondingly tapered part 18 of the inner wall of the housing 2, the nozzle 16 being in flow communication with the plenum 8. The nozzle 16 is so shaped as in use to give supersonic flow.

In operation the inlet 4 is connected to a source of a first fluid. In this embodiment this fluid would be the working fluid and would be a mixture of a gas, for example air, and the liquid or liquids to be dispersed, for example water. Introduction of the steam into the mist generator 1 through the feed port 10 and plenum 8 causes a jet of steam to issue forth through the nozzle 16. The parametric characteristics of the steam are selected whereby in use the steam issues from the nozzle at supersonic speeds into the passage 3 which acts as a mixing chamber (3A). The steam jet issuing from the nozzle impacts the working fluid with high shear forces, thus atomising the water into droplets and occasioning induction of the resulting water mist through the passage 3 towards the outlet 5.

Figure 2 shows a second embodiment similar to that illustrated in Figure 1 save that an additional feed port 30 and plenum 32 are provided in the housing 2, together with a further annular nozzle 34 formed at a location coincident with that of the nozzle 16.

In operation in this instance a gas, for example air, is introduced to the inlet 4, and water is introduced to the fluid inlet nozzle 34 from the feed port 30 and the plenum 32 and thence to the passage 3. The high velocity steam jet issuing from the nozzle 16 impacts the water with high shear forces, thus breaking the water into fine droplets and producing a well mixed three-phase condition constituted by the liquid phase of the water, the steam and the air. In this instance, the energy transfer mechanism of momentum and mass transfer occasion's induction of the working fluid through the mixing chamber 3A and out of the outlet 5. In addition this also induces more air to enter the passage 3 through the inlet 4.

The flow rate, velocity and temperature of the water introduced to the fluid inlet nozzle 34 can be regulated to give the required intensity of shearing and droplet formation. The flow rate and velocity of the water being controllable by either an external pressure regulation means, or by the gap size employed within the fluid inlet nozzle 34.

Figure 3 shows a third embodiment similar to that illustrated in Figure 2 save that it is provided with a diverging mixing chamber section 3A. Correspondingly the exit angles of the transport fluid nozzle 16 and the fluid inlet 34 are also angled to provide the desired angles of interaction between the transport and working fluid occasioning the optimum energy transfer by momentum and mass transfer.

In operation the arrangement illustrated provides a more diffuse or wider spray cone angle and therefore a wider mist coverage. The angled walls 36 of the mixing chamber may be varied to provide different spray cone angles.

Referring now to Figure 4 which shows a fourth embodiment similar to that illustrated in Figure 3 save that an additional transport fluid feed port 40 and plenum 42 are

provided in the housing 2, together with a further annular nozzle 44 formed at a location coincident with that of the fluid inlet nozzle 34, thus providing a co-annular nozzle arrangement. The nozzle 44 is so shaped as in use to give supersonic flow. Again, this embodiment is provided with a diverging mixing chamber section 3A and the exit angles of the steam nozzles 16 and 44 and the fluid inlet 34 are also angled to provide the desired angles of interaction between the transport and working fluid, thus occasioning the optimum energy transfer by momentum and mass transfer. The arrangement illustrated provides a more diffuse or wider spray cone angle and therefore a wider mist coverage. The angle of the walls 36 of the mixing chamber may be varied to provide different spray cone angles.

In operation the two high velocity streams of steam exiting their respective nozzles 16 and 44, 'sandwich' the water stream exiting the fluid inlet 34. This both enhances the droplet formation by providing a double shearing action, and also provides a fluid separation or 'cushion' between the water and the walls of the mixing chamber 36. This prevents small water droplets being lost through coalescence on the internal walls of the mixing chamber 36 before exiting the mist generator via the outlet 5.

In alternative embodiments, not shown, the mixing chamber section 3A of Figures 3 and 4 may be converging. This may provide a greater exit velocity for the mist and therefore a greater projection range.

With reference to Figure 5, the embodiment of Figure 1 is disposed centrally within a casing 50 having a diverging inlet portion 52 having an inlet opening 54, a central portion 56 of constant cross section, leading to a converging outlet portion 58 having an outlet opening 60. In use the inlet and outlet openings 54 and 60 are in flow communication with a body of the first fluid either therewithin or connected to a conduit. Although Figure 5 illustrates the use of the embodiment of Figure 1 disposed centrally within the casing 50, it is envisaged that any of the embodiments illustrated in Figures 2 to 4 may also be used instead.

In operation the first fluid is drawn through the casing 50 with flow being induced around the housing 2 and also through the passage 3 of the mist generator which is of similar design to the embodiments illustrated in Figures 1 to 4. The convergent portion 58 of the casing provides a means of enhancing the momentum transfer and mixing between the flow exiting the mist generator at outlet 5 and the fluid drawn through the casing 50. As an alternative to the specific configuration as shown in Figure 5, the inlet portion 52 may display a shallower angle or indeed may be dimensionally coincident with the full bore 56. The outlet portion 58 may be of varied shape to produce different accelerative and mixing performance.

In all embodiments, the fluid inlet nozzle 34 or another fluid inlet nozzle or nozzles may alternatively form the inlet for other fluids, or solids in flowable form such as a powder, for use in mixing or treatment purposes. For example, a further fluid inlet nozzle may be provided in the passage to provide chemical treatment of the working fluid, such as a fire retardant, if necessary. The placement of the fluid inlet nozzles may be either upstream or downstream of the transport fluid nozzle or where more than one fluid inlet nozzle is provided the placement may be both upstream and downstream dependent upon requirements.

Referring to embodiments 1 to 4, for use in applications of fire suppression in a room or other contained volume, the mist generator may be either located entirely within a volume or room containing a fire, or located such that only the exit 5 protrudes into the volume. Consequently, the first fluid entering via inlet 4 may either be the gasses already within the room, these may range from cold gasses to hot products of combustion, or may be a separate fluid supply, for example air from outside the room. In the situation where the mist generator is located entirely within the room, the induced flow through the passage 3 of the mist generator may induce smoke and other hot combustion products to be drawn into the inlet 4 and be intimately mixed with the other fluids within the mist generator. This will increase the wetting and cooling effect on these gasses and particles.

The flow of the first fluid, for example air, through the inlet 4 is controllable. In some applications, for example, the flow of air through the inlet 4 may be restricted or even stopped by closing or blocking the inlet 4 completely. In this configuration, the working fluid, possibly a single fluid, for example water, is introduced into the mist generator through one or more fluid inlets 34. The flow of air may be regulated for different application. For example, generating and introducing water mist containing a large amount of air into a potentially explosive environment such as a combustible gas filled room will result in both the reduction of risk of ignition from the water mist plus the dilution of the gas to a safe gas/oxygen ratio from the air. In addition, the mist generator has a further advantage for use in potentially explosive atmospheres as it has no moving parts or electrical wires or circuitry and therefore has no source of ignition.

Alternatively, if a fire in a contained volume has burnt most of the available oxygen, a water mist may be introduced but with the flow of air stopped. This helps to extinguish the remaining fire without the risk of adding more oxygen. In a further alternative, an inert gas may be used in place of air.

Although the mist generator may use a hot compressible transport fluid such as steam, this system is not to be confused with existing steam flooding systems which produce a very hot atmosphere. In the current invention, the heat transfer between the steam and the working fluid results in a relatively low water mist temperature. The maximum exit temperature within the mist at the point of exit 5 has been recorded at less than 52°C, reducing through continued heat transfer between the steam and water to room temperature within a short distance. The exit temperature of the water mist is controllable by regulation of the steam supply conditions, i.e., flow rate, pressure etc, and the water flow rate conditions, i.e. flow rate, velocity and temperature. Droplet formation within the mist generator may be further enhanced with the entrainment of chemicals such as surfactants. The surfactants can be entrained directly into the mist generator and intimately mixed with the working fluid at the point of droplet formation, thereby minimizing the quantity of surfactant required.

The mist generator has a number of fundamental advantages over conventional water mist systems in that the mechanism of droplet formation is controlled by a number of adjustable parameters. This provides accurate control of the amount of water used, the droplet size, the spray cone angle and the projected range of the mist. For example, a water mist generator using steam as the transport fluid can produce a water mist with a high percentage of water droplets in the 40-50μm size range, with an adjustable spray cone angle and a projected range of over 40m.

The mist generator can be used for either short burst operation of continuous running. As there are no moving parts in the system, and the mist generator is not dependent on small sized and closely toleranced fluid inlet nozzles there is very little maintenance required. It is known that due to the small orifice size and high water pressures used by some of the existing water mist systems that nozzle wear is a major issue with these systems. In addition, due to the use of relatively large fluid inlet nozzles in the mist generator it is less sensitive to poor water quality. In cases where the mist generator is to be used in a marine environment, even sea water may be used.

Due to the relatively low pressures involved in the present invention, the mist generator can be easily relocated and re-directed while in operation. Using appropriate flexible steam and water supply pipes the mist generator is easily man portable. It is also envisaged that the steam source could be chemically generated so providing the possibility that the whole system could become man-portable, possibly utilizing a back-pack arrangement.

It is this versatility that allows the present invention to be applied in many different applications over a wide range of operating conditions. Furthermore the shape of the mist generator may be of any convenient form suitable for the particular application. Thus the mist generator may be circular, curvilinear or rectilinear, to facilitate matching of the mist generator to the specific application or size scaling. For example the mist generator could be made to fit a standard door letterbox to allow fire fighters to easily treat a house fire without the need to enter the building. Size scaling is

important in terms of being able to readily accommodate differing designed capacities in contrast to conventional equipment.

The present invention thus affords wide applicability with improved performance over the prior art proposals in the field of water mist generators

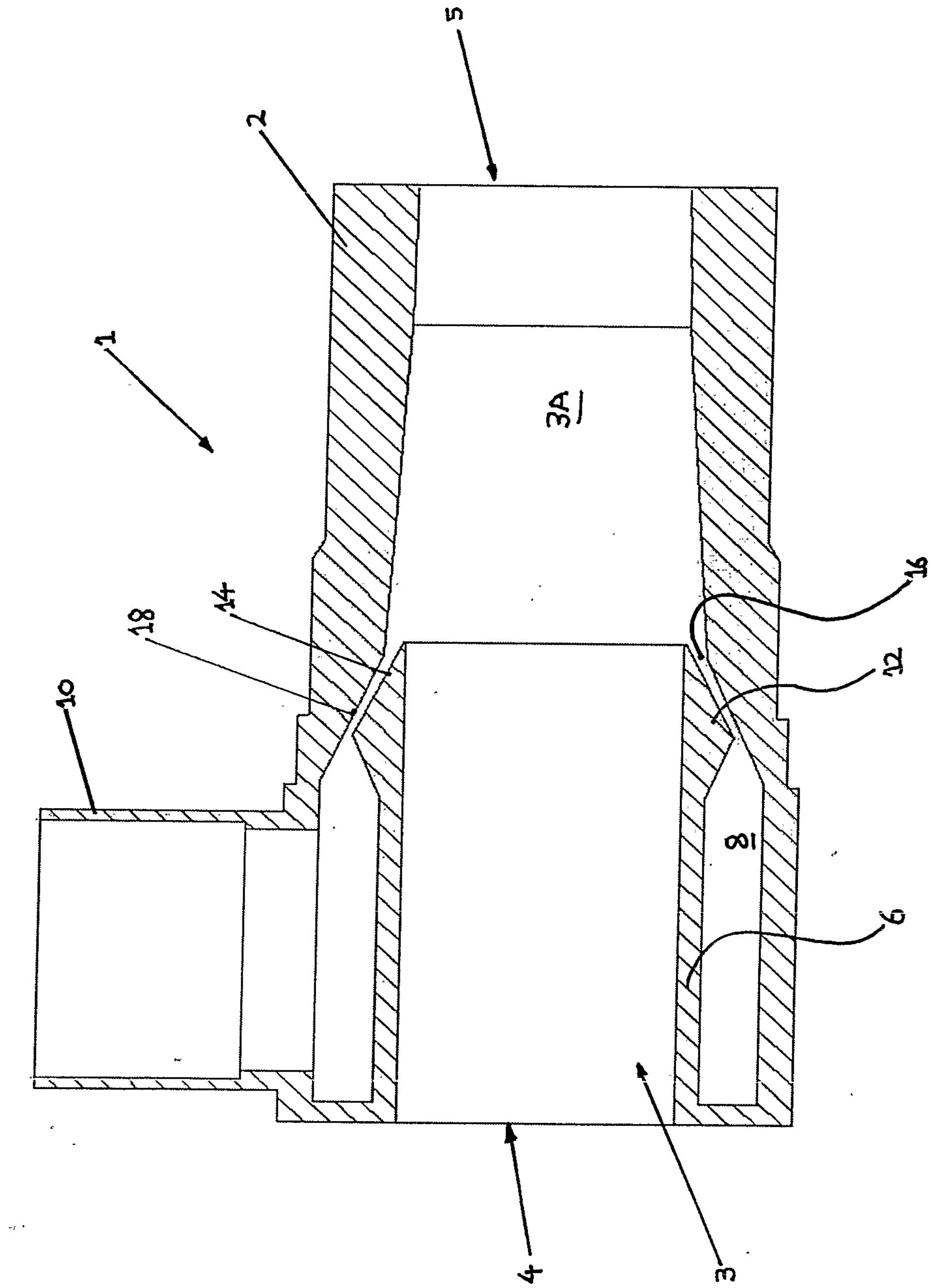

Figure 1

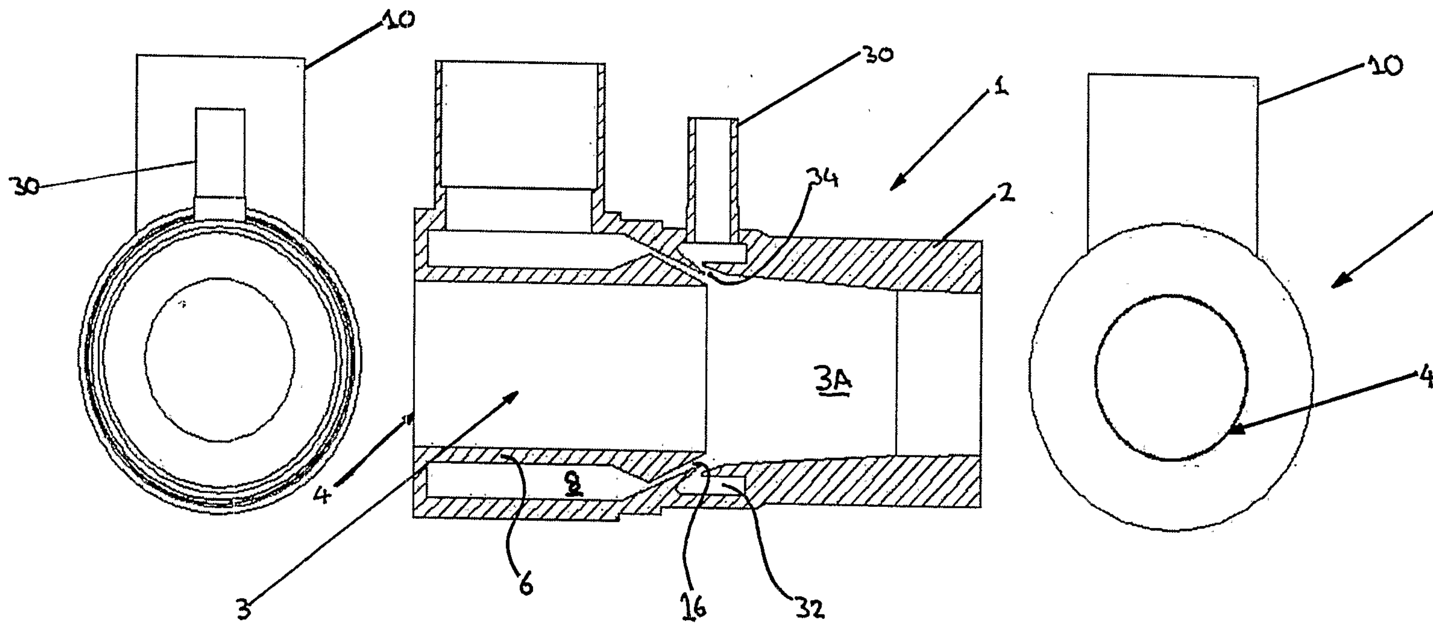

FIGURE 2

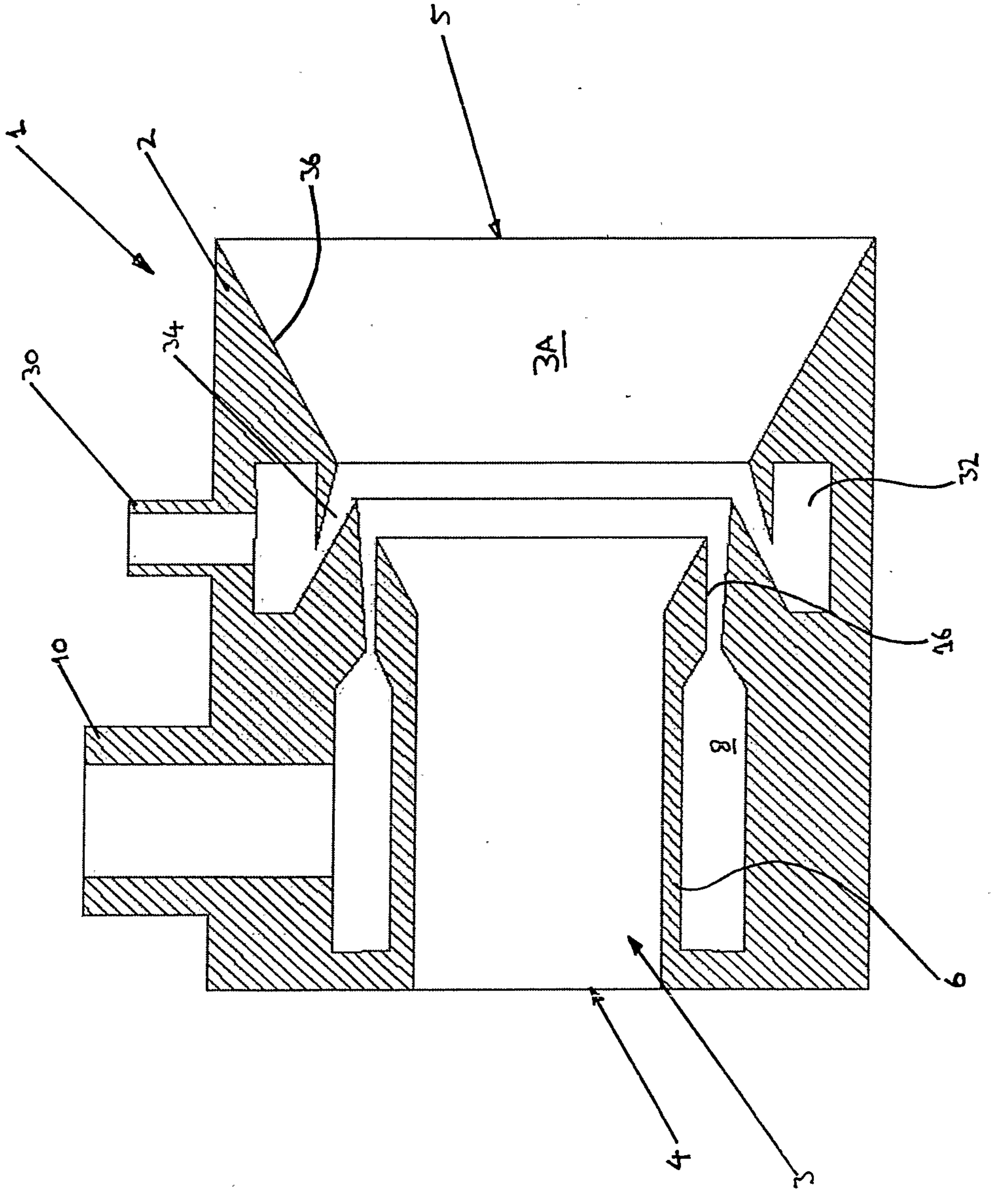

FIGURE 3

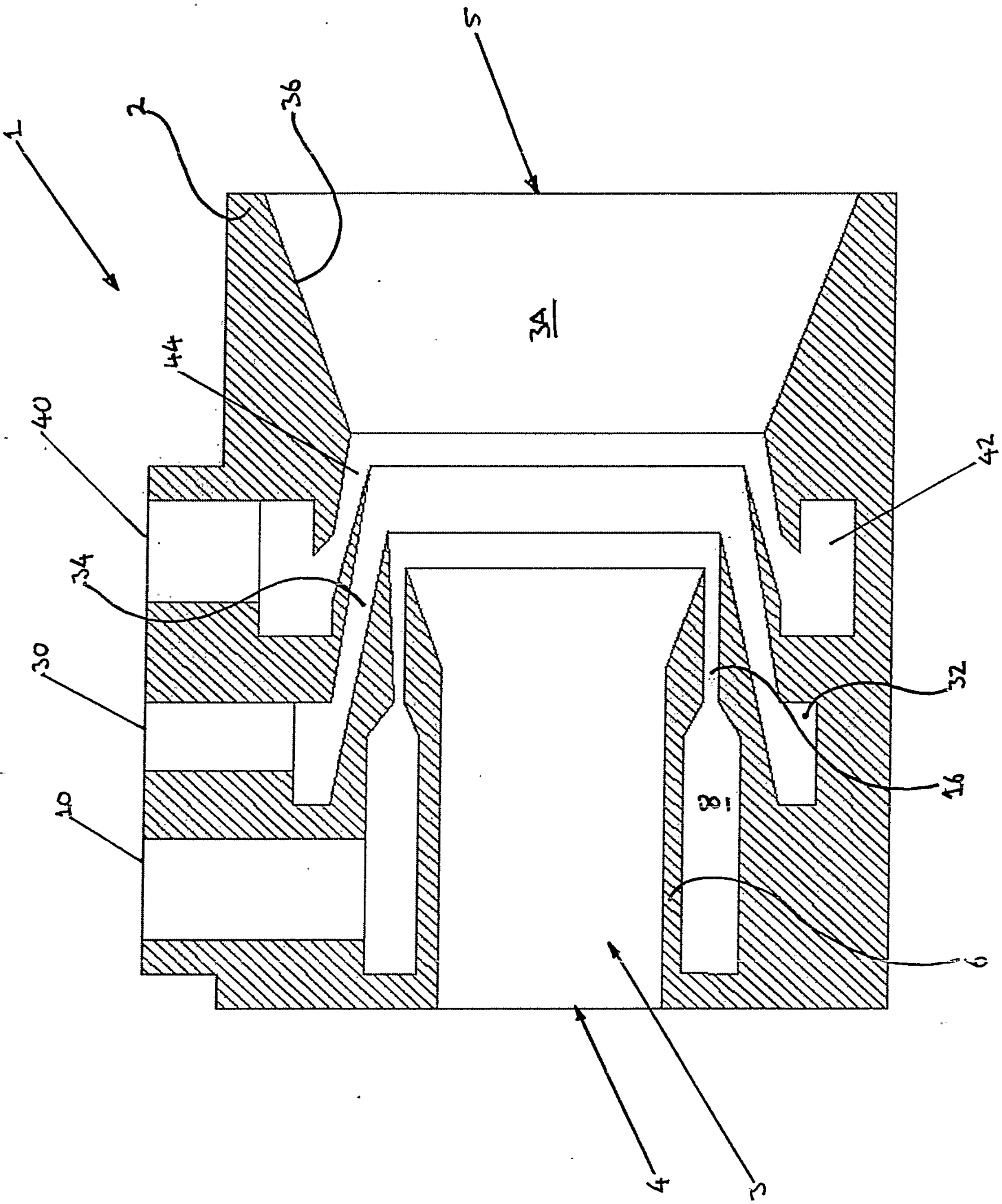

FIGURE 4

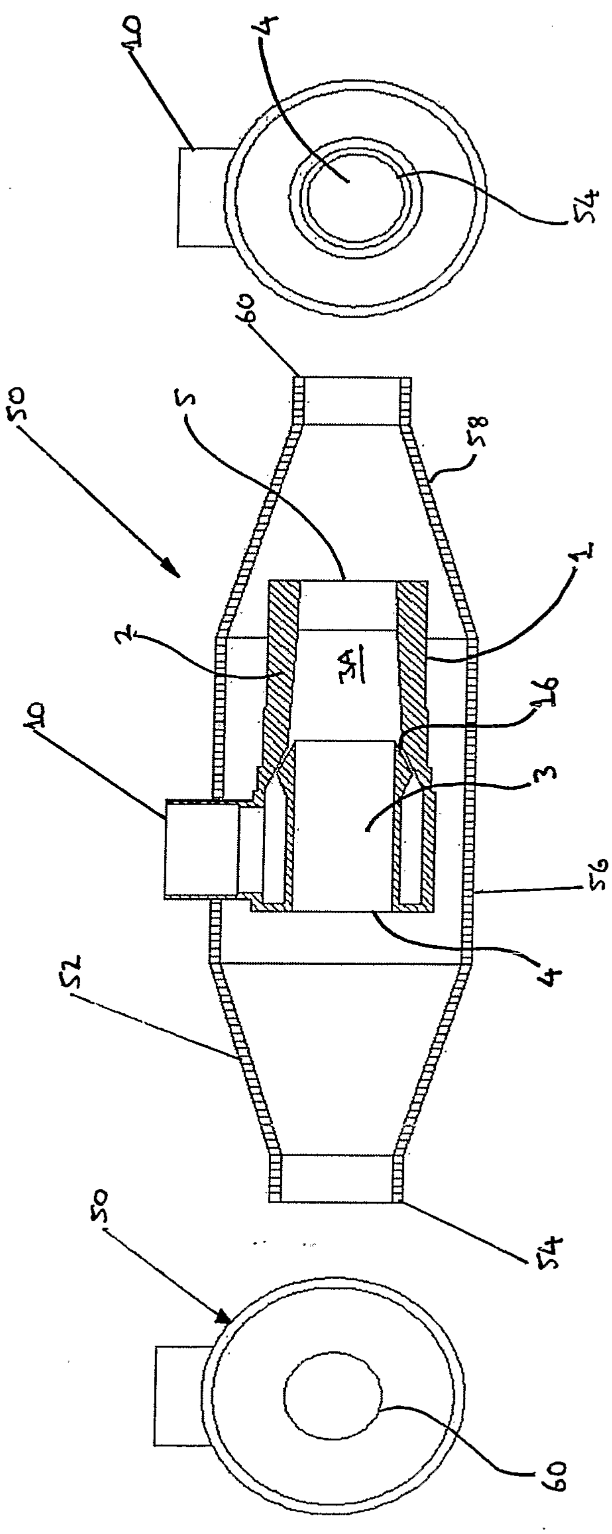

FIGURE 5